



## Three new species of *Helicopsyche* von Siebold (Trichoptera: Helicopsychidae) from Brazil

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### Abstract

Three new species of *Helicopsyche* subgenus *Feropsyche* (Trichoptera: Helicopsychidae) from southern and southeastern Brazil are diagnosed, described, and illustrated: *Helicopsyche angeloi* **sp. nov.** (Holotype male deposited in MZSP: Minas Gerais, Rio de Janeiro and São Paulo States), *H. guara* **sp. nov.** (Holotype male deposited in MZSP: Minas Gerais and Santa Catarina States) and *H. lazzariae* **sp. nov.** (Holotype male in MZSP: Paraná State). The first two species are similar to *H. cipoensis* Johanson & Malm, 2006, and *H. timbira* Silva, Santos & Nessimian, 2014, in having similarly shaped inferior appendages. However, the new species differs in the morphology and distribution of setae on the inferior appendages and tergum X. *Helicopsyche lazzariae* **sp. nov.** is unlike any other described species in the subgenus *Feropsyche* because of its broad deltoid-shaped inferior appendage and absence of a basomesal process on the inferior appendage. Characters important for diagnosing and describing new species of *Helicopsyche* (*Feropsyche*) are discussed. Finally, an updated checklist of the 23 species recorded for Brazil is presented.

**Key words:** aquatic insects, biodiversity, caddisflies, *Feropsyche*, Neotropical, taxonomy

### Introduction

Helicopsychidae comprise about 270 extant species (Holzenthal *et al.* 2011) divided into two genera, the monotypic *Rakiura* McFarlane, 1973, from New Zealand, and the cosmopolitan genus *Helicopsyche* von Siebold, 1856 (Holzenthal *et al.* 2007). The genus *Helicopsyche* is represented in all biogeographical regions, except Antarctica, and with highest species diversity in the tropics, between 5–30°N and 15–45°S (Johanson 1997). Johanson (1998) revised the family and recognized 6 subgenera of *Helicopsyche*, including, in addition to the nominotypical subgenus, *Saetotrichia* Brauer, 1865, *Cochliopsyche* Müller, 1885, *Petrotrichia* Ulmer, 1910, *Feropsyche* Johanson, 1998, and *Galeopsyche* Johanson, 1998.

There are 120 described species of *Helicopsyche* from the Neotropics, including three extinct species from the Dominican Republic (Wichard 2007), placed in two subgenera, *Cochliopsyche* and *Feropsyche*. *Cochliopsyche* is endemic to the Neotropics. Within the Neotropical members of the family, adults of *Cochliopsyche* can be recognized based on a tibial spur formula of 1, 2, 2 and very long antennae (much longer than the body) (Monson *et al.* 1988; Johanson 2003). The subgenus *Feropsyche* is exclusively New World and occurs in both the Neotropical and Nearctic regions. Adults can be distinguished by a tibial spur formula of 2, 4, 4 and by having antennae about as long as, or slightly longer than, the length of the body (Johanson 2002). Larvae of both subgenera build spiral cases of sand grains resembling snail shells (Monson *et al.* 1988; Wiggins 2004).

In Brazil, 23 species of *Helicopsyche* have been recorded (Table 1), nine species in *Cochliopsyche* and fourteen in *Feropsyche*, including three new species proposed here and two species, *H. braziliensis* (Swainson, 1840) and *H. helicoidella* (Vallot, 1855), described exclusively based on larval cases. The latter two species might represent species described as adults more recently under other names (Johanson 2002). The three new species described and

illustrated here are from southeastern and southern Brazil and are members of the subgenus *Feropsyche* Johanson, 1998.

**TABLE 1.** *Helicopsyche* species recorded from Brazil (\* indicates species distribution records not recorded by Paprocki & França 2014). The abbreviations of Brazilian states are presented in parentheses (distributional data from Flint *et al.* 1999; Johanson 2003; Blahnik *et al.* 2004; Johanson & Malm 2006; Chamorro-Lacayo *et al.* 2007; Dumas *et al.* 2009; Calor 2011; Dumas & Nessimian 2011; Souza *et al.* 2013; Paprocki & França 2014). Abbreviations for Brazilian States: AM = Amazonas; BA = Bahia; MG = Minas Gerais; MT = Mato Grosso; PA = Pará; PE = Pernambuco; PR = Paraná; RJ = Rio de Janeiro; RO = Rondônia; RR = Roraima; SC = Santa Catarina; SP = São Paulo.

Species	Distribution
<i>H. (Cochliopsyche) amazona</i> Johanson, 2003	Brazil (AM)
<i>H. (Cochliopsyche) amica</i> Johanson, 2003	Brazil (AM*, PA), Guyana, Venezuela
<i>H. (Cochliopsyche) blahniki</i> Johanson, 2003	Brazil (AM), Colombia, Ecuador, Guyana, Peru, Venezuela
<i>H. (Cochliopsyche) brazilia</i> Johanson, 2003	Brazil (MG)
<i>H. (Cochliopsyche) clara</i> (Ulmer), 1905	Argentina, Brazil (AM, MG, MT, PA, PR, RJ, RO, RR, SC, SP), Ecuador
<i>H. (Cochliopsyche) lobata</i> Flint, 1983	Argentina, Brazil (MG, SC), Peru
<i>H. (Cochliopsyche) opalescens</i> Flint, 1972	Argentina, Brazil (AM, MG, MT, PA, PE*, PR, RJ, RO, RR, SC, SP), Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela
<i>H. (Cochliopsyche) pandeirosa</i> Johanson, 2003	Brazil (MG)
<i>H. (Cochliopsyche) xinguensis</i> Johanson, 2003	Brazil (AM, PA)
<i>H. (Feropsyche) angeloi</i> <b>sp. nov.</b>	Brazil (MG, RJ, SP)
<i>H. (Feropsyche) braziliensis</i> (Swainson), 1840	Brazil (?)
<i>H. (Feropsyche) cipoensis</i> Johanson & Malm, 2006	Brazil (MG)
<i>H. (Feropsyche) flinti</i> Johanson, 1999	Brazil (SC)
<i>H. (Feropsyche) guara</i> <b>sp. nov.</b>	Brazil (MG, SC)
<i>H. (Feropsyche) helicoidella</i> (Vallot), 1855	Brazil (BA)
<i>H. (Feropsyche) lazzariae</i> <b>sp. nov.</b>	Brazil (PR)
<i>H. (Feropsyche) monda</i> Flint, 1983	Argentina, Brazil (MG, PR, RJ, SC, SP), Paraguay, Venezuela
<i>H. (Feropsyche) muelleri</i> Banks, 1920	Brazil (SC), Peru
<i>H. (Feropsyche) paprockii</i> Johanson & Malm, 2006	Brazil (MG)
<i>H. (Feropsyche) planorboides</i> Machado, 1957	Brazil (MG)
<i>H. (Feropsyche) timbira</i> Silva, Santos & Nessimian, 2014	Brazil (RJ, SP)
<i>H. (Feropsyche) valligera</i> Flint, 1983	Argentina, Brazil (SC)
<i>H. (Feropsyche) vergelana</i> Ross, 1956	Belize, Brazil (PE), Costa Rica, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad, Venezuela

## Material and methods

Ultraviolet lights, alcohol pan traps, and diurnal sweep-netting were used to collect adult specimens (Calor & Mariano 2012; Blahnik & Holzenthal 2004). To identify the species, genitalia were treated in 85% lactic acid as described by Blahnik *et al.* (2007) and Holzenthal & Andersen (2004). Genitalia were examined using a stereomicroscope (Olympus SZX12) at 40–100 X magnification. Structures were traced in pencil with the aid of a drawing tube mounted on the microscope. Pencil sketches were then scanned to use as templates to prepare digital vector images using the software Adobe Illustrator CS6 (Adobe Inc.). The morphological terminology was based on that of Johanson & Holzenthal (2004, 2010), except we apply the term inferior appendage rather than gonopod or gonocoxite.

Type specimens are deposited in the Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil (MZSP), Museu de Zoologia da Universidade Federal da Bahia, Salvador, Bahia, Brazil (UFBA), and the University of Minnesota Insect Collection, St. Paul, Minnesota, USA (UMSP), as indicated in the species descriptions.

## Results

### *Helicopsyche (Feropsyche) angeloi* sp. nov.

(Figures 1A–E)

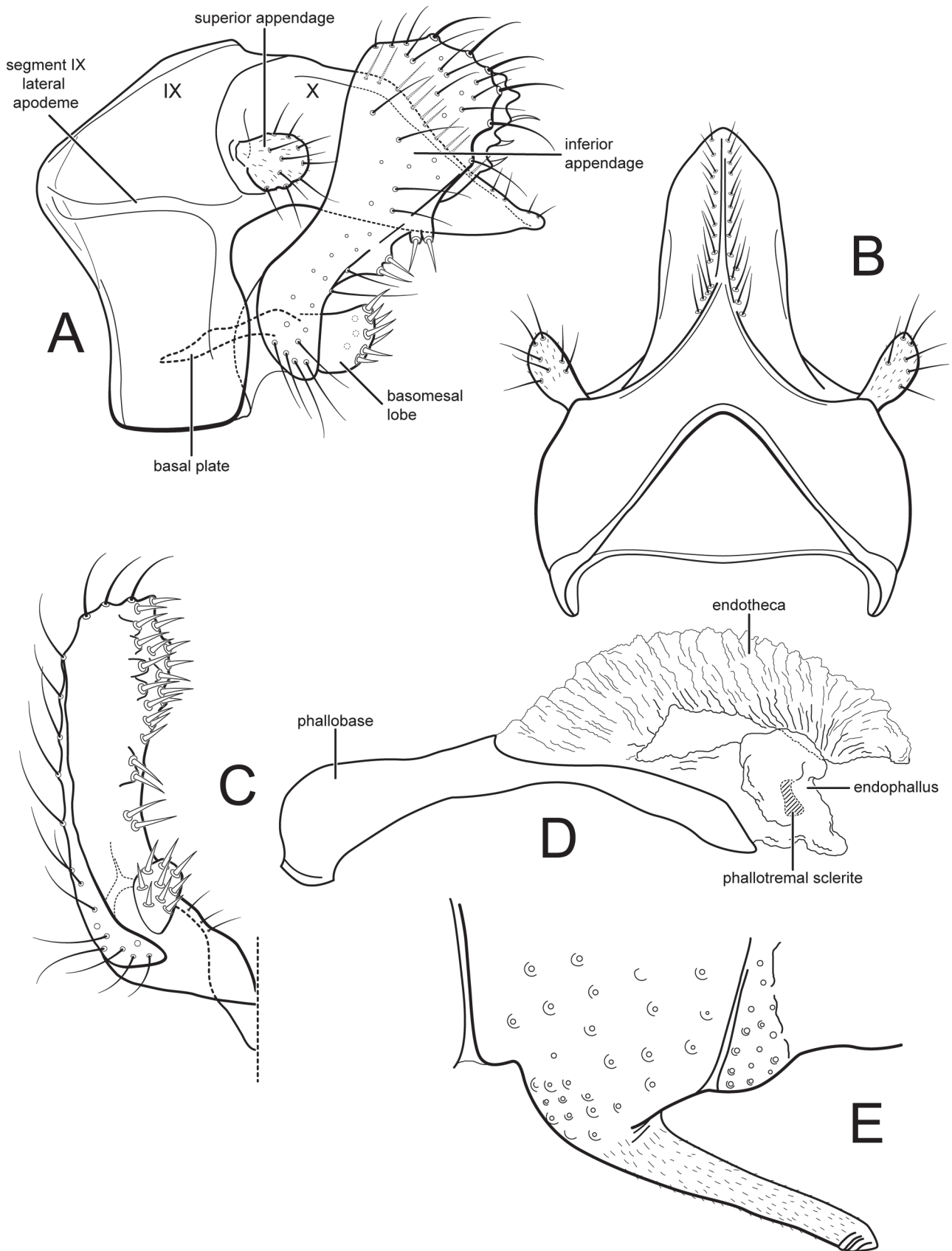
**Material examined. Holotype male. BRAZIL. Minas Gerais:** Córrego das Águas Pretas & tribs., ca. 15 km S Aiuruoca, 22°03.704'S, 44°38.241'W, el. 1386 m, 21.xi.2001, Holzenthal, Paprocki, Blahnik and Neto leg., UMSP000082582 (pinned) (MZSP). **Paratypes: Minas Gerais:** same data as holotype, 2 males, 2 females (pinned) (UFBA), 7 males, 7 females (pinned) (UMSP); Rio Tanque, ca. 12 km (rd) from Ipoema, 19°32.208'S, 43°26.878'W, el. 750 m, 16.V.1998, Holzenthal and Paprocki leg., 1 male (alcohol) (UMSP); Parque Estadual de São Gonçalo do Rio Preto, Córrego das Eguas, 18°08.716'S, 43°22.157'W, el. 891 m, 14.x.2000, Paprocki, Amarante and Isaac leg., 1 male (alcohol) (MZSP); **São Paulo:** Estação Biológica de Boracéia, Rio Coruja, 23°40.10'S, 45°53.96'W, el. 850 m, 18.iv.1998, Holzenthal, Melo and Froehlich leg., 1 male (pinned) (UMSP); **Rio de Janeiro:** Rio Macacu (2nd order) on RJ 116, km 62, 22°23.201'S, 42°33.945'W, el. 840 m, 17.iii.1996, Holzenthal, Rochetti and Oliveira leg., 1 male, 6 females (pinned) (UMSP).

**Diagnosis.** *Helicopsyche angeloi* sp. nov. is similar to *H. timbira* Silva, Santos & Nessimian, 2014, *H. cipoensis* Johanson & Malm, 2006, and *H. guara* sp. nov., all from Brazil. All of these species have clavate inferior appendages, each without an acute apical projection on the posterior margin and with prominent basomesal lobes of the inferior appendages, evident in lateral view. All, except *H. guara* sp. nov., also have nearly linear rows of setae on tergum X. The overall shapes of the inferior appendages are most similar between *H. angeloi* sp. nov. and *H. timbira* in being narrow in lateral view. However, in *H. angeloi* sp. nov., the inferior appendages bear very prominent spine-like setae on their apicomesal face and mesally at midlength. These prominent setae are not present on the inferior appendages in any of the other species. Also, the apex of segment X is slightly cleft in *H. timbira*, but entire in *H. angeloi* sp. nov.

**Description. Male.** Overall color (pinned) nearly uniformly medium brown; dorsum of head with whitish setae, especially between antennae; antennae light brown; palps dark brown. Tibial spur formula 2, 4, 4. Forewing: length 4.5–5.0 mm (n = 10); covered with fine, short, brown setae, anal margin with whitish setae. Abdominal sternum VI process long, almost as long as segment VI, tubular along its length, oriented posteroventrally, nearly straight in lateral view, with microtrichiae along length, apex tapering, with lamellae apicoventrally (Fig. 1E). **Genitalia.** Segment IX long ventrally; anteromesal margin well-developed; lateral apodeme well developed, located midlaterally on segment (Fig. 1A). Segment X conical along basal 2/3, tapering to apex, not divided apically; mesodorsal borders inverted Y-shaped, bearing 2 nearly linear rows of 10–12 setae along length (Fig. 1B); in lateral view, ventral margin almost straight, dorsal margin parallel to ventral margin along basal half, apical half angled posteroventrally (Fig. 1A). Superior appendage originates dorsolaterally, short, setose, rounded (Fig. 1A). Inferior appendage clavate, with anterior margin slightly concave and posterior margin convex; apicodorsal margin undulate, with long setae along apical margin (Figs 1A, C) and spine-like setae apicomesally; 4 spine-like setae at midlength, each on distinct protuberance (Figs 1A, C); basomesal lobe of inferior appendage well-developed, ovate, apically bearing 8–10 spine-like setae (Figs 1A, C); basal plate of inferior appendages nearly straight in lateral view (Fig. 1A), narrow along its length, tapering apically (Fig. 1B). Phallus tubular, slightly down-curved along its length; phallobase narrow, slightly inflated basodorsally, narrow in the middle, apicoventral half strongly sclerotized, acuminate apically; endotheca a large, long, membranous lobe extending dorsally over endophallus; endophallic membranes extended laterally as rounded lobes; phallotremal sclerite small, quadrangular (Fig. 1D).

**Etymology.** Named in honor of Dr. Angelo B. M. Machado, the first Brazilian researcher to describe a species of *Helicopsyche*, *H. planorboides* Machado, 1957, on the occasion of his 80<sup>th</sup> birthday.

**Distribution.** Brazil (Minas Gerais, Rio de Janeiro, and São Paulo).



**FIGURE 1.** *Helicopsyche (Feropsyche) angeloi* sp. nov., male. A. genitalia, lateral view; B. segments IX and X, dorsal view; C. inferior appendage, ventral view; D. phallus, lateral view; E. sternum VI, lateral view. Abbreviations: IX = segment IX; X = tergum X.



***Helicopsyche (Feropsyche) guara* sp. nov.**

(Figures 2A–E)

**Material examined. Holotype male. BRAZIL. Santa Catarina:** Rio Caeté, at entrance to Parque Ecológico Spitzkopf, 27°00.350'S, 49°06.650'W, el. 92 m, 28.xi.2003, Holzenthal, Paprocki and Calor leg., UMSP000120783 (pinned) (MZSP). **Paratypes: Santa Catarina:** same data as holotype, except, 2 males, 4 females (pinned) (UMSP), 1 male, 2 females (pinned) (UFBA); Parque Ecológico Spitzkopf, confl. Rio Ouro and Rio Caeté, 27°00.352'S, 49°06.693'W, el. 140 m, 3.iii.1998, Holzenthal, Froehlich, and Paprocki leg., 3 males, 3 females (pinned) (UMSP); same, except 25.xi.2003, Holzenthal, Paprocki, and Calor leg., 15 males, 8 females (pinned) (UMSP), 28 males, 54 females (alcohol) (UMSP); Ribeirão Gaspar, Belchior Alto, Gaspar, 26°48.373'S, 49°02.465'W, el. 120 m, 27.xi.2003, Holzenthal, Paprocki, and Calor leg., 1 male, 4 females (pinned) (UFBA); Parque Ecológico Spitzkopf, Rio Caeté above 1st falls, 27°00.35'S, 49°06.70'W, el. 170, 26.xi.2003, Holzenthal, Paprocki, and Calor leg., 1 male, 1 female (pinned) (MZSP); **Minas Gerais:** Parque Nacional Peruaçu, Rio Peruaçu, 15°06.674'S, 44°14.487'W, el. 590 m, 16.xi.2001, Holzenthal, Paprocki, Blahnik, and Amarante leg., 3 males, 4 females (pinned), 5 males, 3 females (alcohol) (UMSP), 4 males (alcohol) (UFBA).

**Diagnosis.** This new species is similar to *H. timbira*, *H. cipoensis*, and *H. angeloi* **sp. nov.**, mainly in the shape of the inferior appendage, which is clavate in all four species. *Helicopsyche guara* **sp. nov.** differs from the other three species in having an apically narrow basomesal process of the inferior appendage, which has only 5–6 short spine-like apical setae. It is also distinctive among these species in having segment X shallowly divided apically into 2 short, truncate lobes bearing a broad patch of apical setae, rather than a linear row.

**Description. Male.** Overall color (pinned) nearly uniformly medium brown; dorsum of head with white setae, especially between antennae; antennae whitish basally, grading to pale brown apically; palps dark brown. Tibial spur formula 2, 4, 4. Forewing: length 4.5–5.2 mm ( $n = 10$ ); covered with fine, short, brown setae, anal margin with light brown setae. Sternum VI process long, about as long as segment VI, tubular along its length, oriented posteroventrally, nearly straight in lateral view, with microtrichiae along length, apex tapering, with lamellae apicoventrally (Fig. 2E). **Genitalia.** Segment IX short ventrally; anteromesal margin well developed; lateral apodeme well developed, located midlaterally on segment (Fig. 2A). Segment X triangular, tapering to apex; in dorsal view shallowly divided apically into 2 short, truncate lobes; bearing 2 rows of 14–18 setae, apical setae slightly shorter than basal setae and covering apical lobes (Fig. 2B). Superior appendage originates dorsolaterally, setose, oval (Fig. 2A). Inferior appendage clavate, widest apically, with anterior margin very slightly concave and posterior margin convex; posterodorsal margin undulate, with long setae along apical margins (Fig. 2A); with a few setae on protuberant bases on mesal surface (Fig. 2C); basomesal lobe of inferior appendage well-developed, long, wide basally, tapering to narrow apex, bearing 5–6 short, spine-like setae on upper apical surface (Figs 2A, C); basal plate of inferior appendages nearly straight in lateral view (Fig. 2A), narrow along its length in ventral view, tapering apically (Fig. 2B). Phallus tubular, down-curved along its length; phallobase narrow, slightly inflated basally, narrow in the middle, apicoventral half sclerotized, subacuminate apically; endotheca a large, long, membranous lobe extending dorsally over endophallus; endophallic membranes extended laterally as rounded lobes; phallotremal sclerite small, oval (Fig. 2D).

**Etymology.** The specific name “guara” is in reference to “Lobo-guará”, the Brazilian Portuguese common name for *Chrysocyon brachyurus* (Illiger, 1815), the largest canid in South America, and an amazing character in the children’s book “Chapeuzinho Vermelho e o Lobo-Guará” written by Dr. Angelo B.M. Machado.

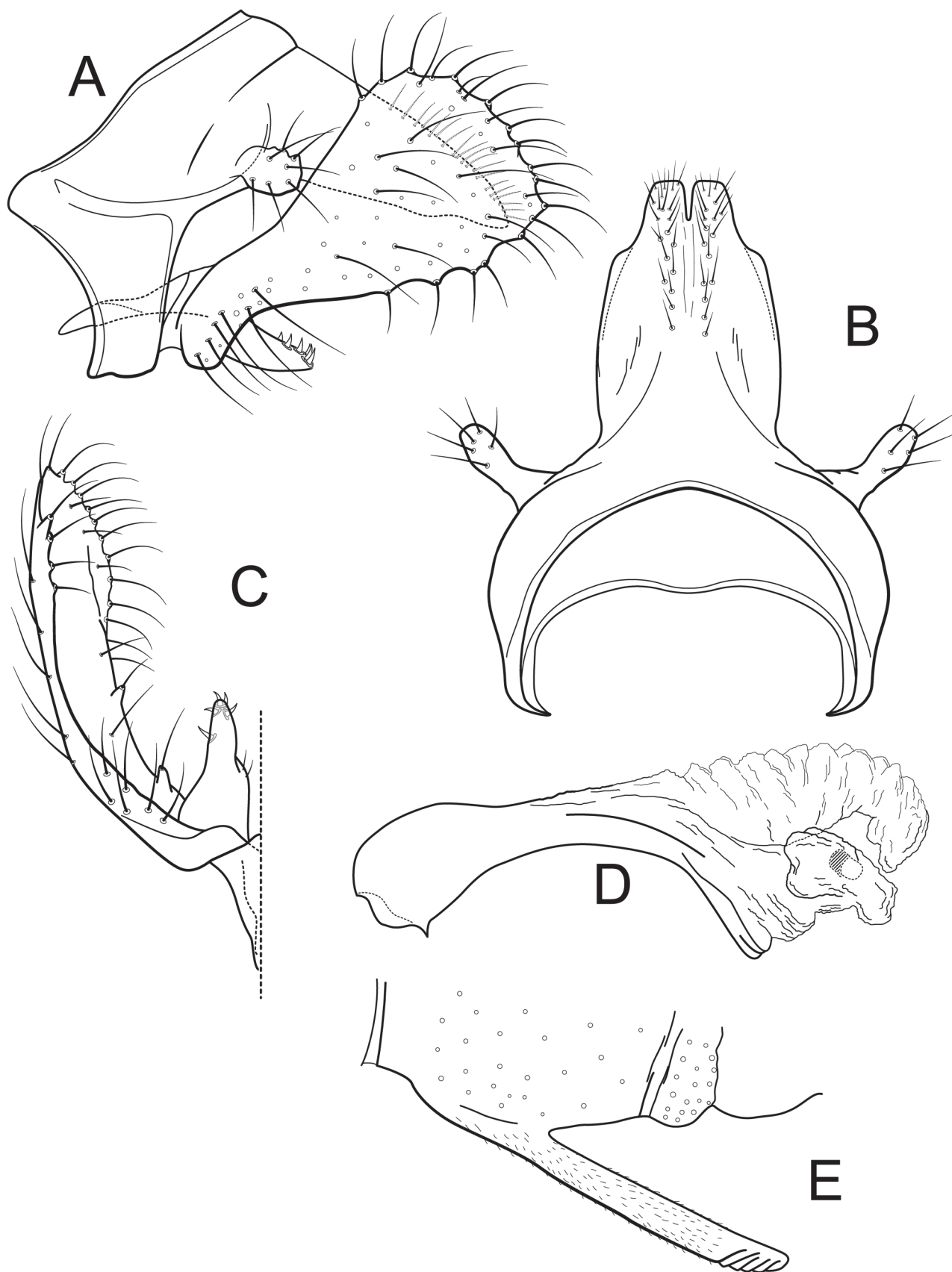
**Distribution.** Brazil (Minas Gerais, Santa Catarina).

***Helicopsyche (Feropsyche) lazzariae* sp. nov.**

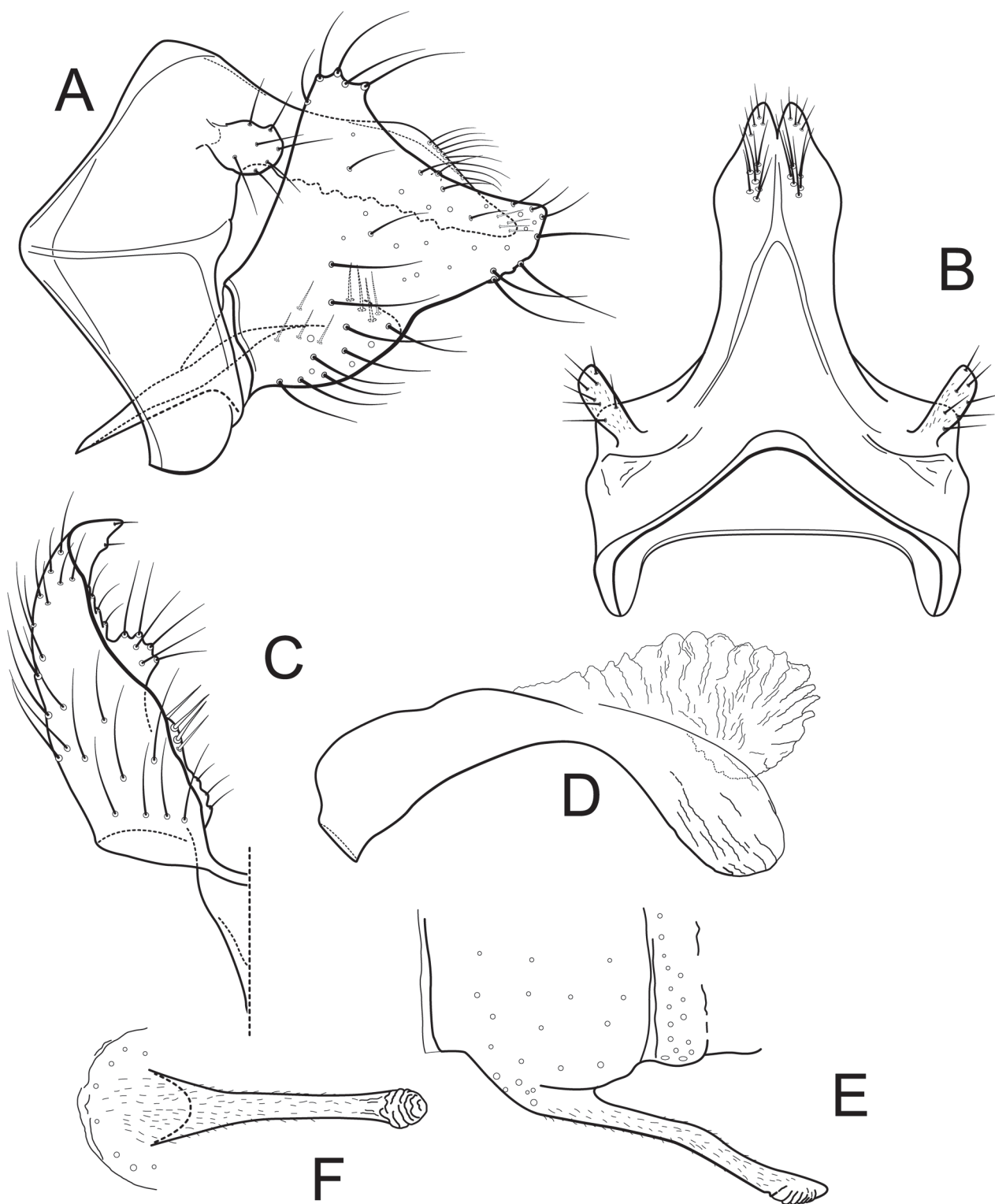
(Figures 3A–F)

**Material examined. Holotype male. BRAZIL: Paraná:** Voçoroca, along main road to Joinville, 25°50.332'S, 49°03.332'W, el. 650 m, 14.iii.1996, Holzenthal and Lázzari leg., UMSP000040750 (alcohol) (MZSP).

**Diagnosis.** *Helicopsyche lazzariae* **sp. nov.** is unlike any other species in the subgenus *Feropsyche* in having an inferior appendage that is broadly deltoid in shape and lacking a distinct basomesal process. Also the posterodorsal margin of the inferior appendage is weakly concave with sparse marginal setae. The shape and setation of tergum X is also distinctive, as described below.



**FIGURE 2.** *Helicopsyche* (*Feropsyche*) *guara* **sp. nov.**, male. A. genitalia, lateral view; B. segments IX and X, dorsal view; C. inferior appendage, ventral view; D. phallus, lateral view; E. sternum VI, lateral view.



**FIGURE 3.** *Helicopsyche (Feropsyche) lazzariae* sp. nov., male. A. genitalia, lateral view; B. segments IX and X, dorsal view; C. inferior appendage, ventral view; D. phallus, lateral view; E. sternum VI, lateral view; F. sternum VI, ventral process, ventral view.

**Description.** *Male.* Overall color (in alcohol) nearly uniformly brown. Tibial spur formula 2, 4, 4. Forewing: length 4.0 mm ( $n = 1$ ); denuded. Sternum VI process long, narrow, longer than segment VI, tubular along its length, oriented posteroventrally, with microtrichiae along length, apex tapering, with lamellae apicoventrally (Fig. 3E), slightly sinuate in lateral view, straight in ventral view (Fig. 3F). *Genitalia.* Segment IX short, rounded ventrally;

anteromesal margin well developed; lateral apodeme developed, narrow, located midlaterally on segment (Fig. 3A). Segment X dorsoventrally flattened, widest in middle, ventral margin undulate; in dorsal view shallowly divided apically into 2 rounded lobes; laterally bearing 2 setose areas, more basal area with 7 long setae, apical area with 4 shorter setae (Fig. 3B). Superior appendage originates dorsolaterally, setose, oval (Fig. 3A), digitate, in dorsal view (Fig. 3B). Inferior appendage large, deltoid, with anterior margin slightly concave, posterior margin convex, and posterodorsal margin weakly concave, with sparse marginal setae; dorsal corner prominent, bearing long setae (Fig. 3A); wide basally, with long basoventral setae; mesal surface with 4 narrow, spine-like setae at middle length on slight protuberance (Figs 3A, C); basomesal lobe of inferior appendage absent (Fig. 3A); basal plate of inferior appendage straight in lateral view (Fig. 3A), narrow along its length, tapering apically (Fig. 3B). Phallus tubular, strongly down-curved along its length; phallobase narrow, slightly inflated basodorsally, narrowest in the middle, rounded apically, apex semi-membranous; endotheca a large, short, membranous lobe extending dorsally over endophallus; endophallic membranes not inflated; phallotremal sclerite not apparent (Fig. 3D).

**Etymology.** Named in honor of Dr. Sonia Lazzari (Universidade Federal do Paraná), one of the collectors of the specimen, friend, and colleague of the authors.

**Distribution.** Brazil (Paraná).

### Discussion on morphology of male genitalia of *Helicopsyche* (*Feropsyche*)

The male genitalia of many species of *Helicopsyche* (*Feropsyche*) are very similar. Critically important diagnostic features of the male genitalia, which should be illustrated comparatively when describing new species, include the shape of the inferior appendage and its setation, especially in lateral and ventral views. The inferior appendage often has prominent setae on its margin, which makes its marginal contour shape irregular. Often these setae are on projecting setal bases; the degree of projection is variable, even within a species. This marginal variation may not be as important as the overall shape of the inferior appendage, but it should be assessed. Further, the apicodorsal corner of the inferior appendage is often drawn out into an attenuate process, which may be mesally curved and not obvious in lateral view, depending on the position of the specimen when it is illustrated. Other important aspects of the inferior appendage include the length, shape, and setation of its basomesal lobe, and the presence of setae or spine-like setae on the mesal surface of the main lobe of the inferior appendage. Also of critical importance in diagnosing species is the shape and length of tergum X and the number, arrangement, and size of setae, including their setal sockets. The length and shape of the ventral process of segment VI is also of some diagnostic value in its gross morphology, but usually as a supplemental character. Important literature for identifying and diagnosing Neotropical *Helicopsyche* includes the works of Johanson (2002, 2003), Johanson & Holzenthal (2004, 2010), Johanson & Malm (2006) and Silva *et al.* (2014).

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